THE EFFECT OF NEGATIVE STIMULUS PRESENTATIONS ON OBSERVING-RESPONSE RATES

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Theories of observing differ in predicting whether or not a signal for absence of reinforcement (S−) is capable of reinforcing observing responses. Experiments in which S− was first removed from and then restored to the procedure have yielded mixed results. The present experiments suggest that failure to control for the direct effect of presenting S− may have been responsible. Pigeons and operant procedures were used. Experiment 1 showed that presentations of S−, even when not contingent on observing, can raise the rate of an observing response that was reinforced only by presentations of a signal (S+) that accompanied a schedule of food delivery. Experiment 2 showed that this effect resulted from bursts of responding that followed offsets of S−. Experiment 3 showed that, when the presence of S− was held constant, lower rates occurred when S− was dependent on, rather than independent of, observing. These results support theories that characterize S− as incapable of reinforcing observing responses.

Key words: observing, negative discriminative stimulus (S−), S− presentations, contingency of S−, information hypothesis, conditioned reinforcement, key peck, pigeons

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Systematic study of artificial observing responses was initiated by Wyckoff (1952) with an experiment in which pigeons' depressing a floor pedal could produce colored lights predicting reinforcement and nonreinforcement at the end of trials of fixed duration. Unless the bird pressed the pedal, the response key remained white, and there was a 50% chance that pecking at the end of the interval would be reinforced. When the bird stood on the pedal and the current interval was to end in reinforcement, a red light appeared on the key. When the current interval was to end without reinforcement, a green light appeared. Pressing the pedal was an artificial observing response that brought the pigeon into contact with discriminative stimuli. Subjects for which colored lights were correlated with reinforcement spent more time on the pedal than did subjects for which they were not correlated.

Artificial observing responses provided a promising tool for the study of basic processes like discrimination learning and conditioned

reinforcement. In addition, however, the occurrence of the responses themselves demanded explanation. In Wyckoff's procedure (1969), in similar operant procedures (e.g., Dinsmoor, Browne, & Lawrence, 1972), and in procedures using an E maze (e.g., Prokasy, 1956), the occurrence of observing responses did not affect the delivery of food. For example, in operant procedures using interval-based food reinforcement schedules, subjects respond at rates sufficient to collect all food reinforcers, regardless of the presence or absence of the stimuli. Thus, no simple increase in food reinforcement can explain the occurrence of artificial observing responses. To the extent that artificial observing-response procedures serve as model systems for the study of conditioned reinforcement, an explanation for the occurrence of observing responses speaks to the nature of conditioned reinforcement itself.

One proposed explanation is the enticing idea that it is the information provided by the stimuli that is reinforcing. This approach not only has intuitive appeal but promised quantitative approaches to conditioned reinforcement derived from information theory (Shannon & Weaver, 1949). A second approach, grounded more closely in theoretical work on classical and operant conditioning, asserted that stimuli that signal reinforcement allow the animal to make preparatory responses that enhance the value of the reinforcer (Perkins,

1955, 1971). For example, after discrimination training, salivation occurs as a conditioned response to the signal for food, and food with salivation is more attractive than food without salivation. Conversely, if the animal refrains from salivating in the absence of food, that outcome is preferable to salivating in the absence of food (Perkins, 1971).

Traditional views of conditioned reinforcement (Kelleher & Gollub, 1962) assert that conditioned reinforcers result from Pavlovian association with primary reinforcers. The association can be based on close temporal pairing, or on more complex relationships such as reduction in delay to reinforcement, differential reinforcement density, or correlation of stimuli with reinforcement. Any traditional approach to explaining artificial observing responses must identify the basis for such an association, in spite of the absence of any change in overall density of reinforcement. Dinsmoor (1983) has developed such a theory. He and his co-workers have found that, in procedures in which the subject is free to terminate as well as to produce stimuli, much less contact occurs with stimuli that accompany the absence of reinforcement (S−) than with stimuli that accompany the availability of reinforcement (S+) (Browne & Dinsmoor, 1974; Dinsmoor, Browne, Lawrence, & Wasserman, 1971; Dinsmoor, Mueller, Martin, & Bowe, 1982). Thus, the density of reinforcement when observing is, in fact, higher than when not observing.

This last, traditional theory of observing differs from the information and preparatory-response theories in one important prediction. Traditional theories of conditioned reinforcement clearly characterize occurrence of S− as punishing. Both information and preparatory-response theories assert that occurrence of S− is reinforcing. Thus, tests of the reinforcing power of S− have been critical to testing these theories.

A straightforward approach to testing the reinforcing power of S− is to omit the S+ from the procedure and thus to assess whether presentations of the S− alone will maintain observing responses. Dinsmoor et al. (1972) performed the first such test. The food was delivered to pigeons on a variable-interval (VI) schedule that alternated with periods of extinction. The food deliveries were contingent on pecking one of two keys; pecks on the second, observing key produced stimulus displays, also delivered on a VI schedule, When the S+ was omitted and only the S− could be produced by pecking the observing key, observing rates quickly and reliably dropped to zero. Subsequent studies have produced comparable results using other schedules of reinforcement (Auge, 1974; Mueller & Dinsmoor, 1984). Similar failures to maintain observing responses have been reported when the responses were followed by stimuli that accompanied a smaller magnitude (Auge, 1973) or lower density of reinforcement (Jwaideh & Mulvaney, 1976). (For a related experiment with rats, see Badia, Ryan, & Harsh, 1981.) Finally, an experiment using pigeons and a concurrent observing procedure indicated that the S− is not merely neutral but is actually punishing: A higher rate of observing responses occurred on a key that produced only S+ than on a key that produced S− as well (Mulvaney, Dinsmoor, Jwaideh, & Hughes, 1974).

An alternative approach to testing the reinforcing power of S− has been to determine the effect on observing rates of omitting it from the procedure. In these experiments, results have been mixed. Dinsmoor et al. (1972) found a small and inconsistent increase in observing when only S+ could be produced. However, using rhesus monkeys as subjects, Lieberman (1972) found a decrease in observing rates when S− was omitted, and a similar result has been found using pigeons (Mueller & Dinsmoor, 1984).

Based on findings that subjects observe the S− for relatively brief durations and on evidence that the effectiveness of a stimulus is related to its duration (Dinsmoor, Mulvaney, & Jwaideh, 1981), one would expect the effects of omitting S− to be of smaller magnitude than the effects of omitting S+. Yet the explanation of the occurrence of observing responses that is based on traditional conditioned-reinforcement theory cannot account in any straightforward way for the direction of the change—that is, the decline in rates of observing that often occurs when S− is omitted.

One possibility is that the omission of S− does indeed work to increase observing rates, as predicted, but that other, opposing processes work to lower those rates. The omission of the S− from observing-response procedures

involves two changes: First, the contingency between observing responses and S– is discontinued. Second, presentation of the S– is discontinued. According to the conditioned-reinforcement theory of observing, the first change should increase observing rates. The hypothesis tested in the present series of experiments is that the second change works to lower those rates, or, in other words, that response-independent presentations of the S– raise observing rates.

EXPERIMENT 1: THE EFFECT OF A NONCONTINGENT S– ON OBSERVING-RESPONSE RATES

The purpose of the first experiment was to test the hypothesis that the mere presentation of the S–, when not contingent upon observing responses, raises the rate of observing responses maintained by presentations of S+. Three conditions were tested: In the *S+ Only* condition, no S– was presented. In the *Free S–* condition, a stimulus signaling the absence of reinforcement was presented independently of the subject's responses. In the *Free Mixed* condition, a stimulus that shared many of the properties of S–, but which did not signal the absence of reinforcement, was presented independently of the subject's behavior.

METHOD

Subjects

Sixteen female White Carneaux pigeons served as subjects. Nine birds had no previous experience in observing procedures and were recruited from an experiment in which pecking had been autoshaped with a white key as CS+ and a white key with a black dot as CS–. The remaining seven birds had served in previous experiments similar to the one reported here, but without the free mixed stimulus (e.g., Mueller & Dinsmoor, 1984, Experiment 2). Subjects were maintained at 75% of their free-feeding weights by postsession feeding.

Apparatus

Two three-key Lehigh Valley pigeon chambers were used, with the right-hand keys masked by a patch of tape. Both remaining keys could be back-lit with red, white, or green lamps. Keys were 2.5 cm in diameter. In each box, the center of the left-hand, observing key was 9.5 cm from the back wall of the chamber. The food key was 8 cm to its right, center-to-center. The force required to operate each key was as follows: box 1, food key: 0.20 N; box 1, observing key: 0.20 N; box 2, food key: 0.13 N; box 2, observing key: 0.16 N. A houselight was centered above the food key in each box. A hopper opening 5.7 cm wide and 5 cm high was located approximately 10 cm from floor to bottom edge and 14.8 cm from back wall to left-hand edge. The work panel measured 35.6 cm high and 33 cm wide.

Both boxes were located in the same room. The observation windows were covered. The keylights and houselights for each of the two boxes were electrically isolated from each other and from the programming circuit. Masking noise was supplied by a speaker in the room that housed the chambers. The noise was approximately 95 dB SPL, measured 5 cm from the speaker. Electromechanical programming and recording equipment was located in an adjacent room.

Procedure

General description. In all three conditions studied, periods of variable-interval food reinforcement alternated with periods of extinction. In the reinforcement components, pecks on the food key were followed by 3-s access to grain every 60 s, on the average (VI 60). Also, in all three conditions studied, pecks on the second, observing key were intermittently followed by green keylight displays on both keys. These green keylights served as the S+, for they were displayed only when the VI food schedule was operating. Observing responses were followed by these displays on a VI 30-s schedule, the tape programmer for which operated only during reinforcement components. The duration of S+, and of the S– and Free Mixed stimulus, described below, averaged 10 s. The relatively short and irregular stimulus duration made it unlikely that offset of S+ or S– would serve as a signal for a component change from VI to extinction or vice versa. In all three conditions, both keylights were white when neither an S+, S–, or Free Mixed stimulus was displayed.

The S+ Only condition. In the S+ Only condition, only the general procedure described above was in effect. VI and extinction food-reinforcement components alternated at

irregular intervals averaging 45 s. Thus, both keys were white unless a reinforced observing response occurred (during the VI component). In that case, the keys changed to green for a brief period of time.

The Free S− condition. In the Free S− condition, observing responses continued to produce S+ displays. In addition, however, noncontingent red keylight displays also occurred during extinction components of the food schedule. These S− displays, like the S+ displays, were of irregular duration, averaging 10 s, and were presented every 30 s on the average (VT 30).

The Free Mixed stimulus. The purpose of the present experiment was to determine the effect of the Free S− presentations on rate of observing responses reinforced by S+. However, presentations of S− introduce a number of changes in the procedure that are not intrinsic to the S− as a signal for the absence of reinforcement. These factors are discussed briefly below (see also Mueller, 1981):

1. When S− is presented, periods occur without key pecking, and these periods might produce an increase in observing responses during other parts of the session. A similar effect was suggested as an explanation of behavioral contrast (Terrace, 1968; Weisman, 1969, 1970). However, it was rejected on the basis of data showing that behavioral contrast did not occur when rates were lowered by a different method (Halliday & Boakes, 1972). A similar strategy was adopted in the present experiment.

2. A second factor confounded with S− presentations concerns the length of periods of mixed-stimulus display, during which the observing responses are made. When the S− is eliminated, the standard mixed stimulus (white) is substituted for the missing S− displays. Therefore, periods spent in the presence of the mixed stimulus are longer in sessions with the S+ Only procedure than in sessions with the Free S− procedure. Rate of responding has been found to be affected, in a nonlinear fashion, by component duration in multiple schedules (e.g., Williams, 1979).

3. More frequent stimulus change occurs when presentations of S− are included in the procedure.

4. Finally, in sessions when the S− is presented, there is an increase in the percentage of time during the mixed stimulus that is spent in the VI component of the food schedule. In the S+ Only condition, all extinction time occurs during the mixed stimulus. In the Free S− condition, some of this extinction time is removed from the mixed stimulus because it is signaled by the S−. McMillan's data (1974) indicate that relative time spent in each component can affect observing rates.

The procedure used to control for these factors was the presentation of a noncontingent, alternative mixed stimulus during which both response keys were darkened and food was presented noncontingently. Presentation of this Free Mixed stimulus introduced periods of reduced responding, shortened the duration of the mixed stimulus, and increased the amount of stimulus change. Also, during Free Mixed sessions, time spent in the reinforced component of the food schedule was artificially increased by adjusting the programming equipment.

Training and pilot sessions. For the birds that were naive to the observing procedure and for which pecking of a white key had been autoshaped, an initial session was run on the Free Mixed procedure. Because these subjects rarely pecked the observing key, the keys remained white for most of the session. After key pecking was reestablished, the keys were made green, and, if necessary, pecking the green food key was hand shaped. In the third session, observing was trained by masking the food key with a piece of tape and reinforcing pecks on the observing key with food and displays of green illumination. During the fourth session, the subjects were again exposed to the full Free Mixed observing procedure; all made observing responses and pecked the food key when it was green. Concurrently with these training sessions for naive birds, the subjects that were experienced with the Free S− and S+ Only procedures were given sessions with the Free Mixed procedure.

Next, four nine-session series were conducted that served both as training and pilot sessions. Three contiguous daily sessions were conducted for each condition. During these preliminary series, adjustments were made in component and stimulus duration. The pur-

poses of the adjustments were to meet the requirements of the Free Mixed condition and to strike a balance between a need to present stimuli for an adequate amount of time and a need to avoid having too large a percentage of stimulus offsets caused by component changes. (At the final average value of 10-s stimulus duration, 44% of stimulus offsets were caused by component changes.)

After these training and pilot sessions, a nine-session test series was conducted, again with three contiguous daily sessions in each condition. Data from the first of the three sessions in each condition were discarded; data from the remaining two sessions were averaged to yield a single data point for statistical analysis. Subjects were tested in squads of two, with the order of the conditions determined randomly.

RESULTS

Table 1 shows individual and mean rates of observing during Free S–, Free Mixed, and S+ Only sessions. Analysis of variance with Condition and History as factors yielded a highly significant effect of Condition [$F(2, 28) = 11.12$, $p = .0003$]. Because the planned comparisons were nonorthogonal, the Scheffe method for post-hoc pairwise comparisons was applied. Observing rates during Free S– sessions were significantly higher than for S+ Only sessions ($p < .01$). Observing rates during Free S– sessions were also significantly higher than during Free Mixed sessions ($p < .05$). The difference between Free Mixed and S+ Only sessions did not achieve significance ($p < .20$).

The interaction between Condition and History approached significance [$F(2, 28) = 2.31$, $p = .12$]. To determine if the main effect for Condition was due to the history of the experienced subjects, data from only the autoshaped subjects were analyzed. The effect of Condition was also significant for these birds [$F(2, 16) = 4.0$, $p = .039$]. However, the Scheffe test for post-hoc comparisons found only the difference between Free S– and S+ Only to be significant ($p < .05$).

An analysis of variance with Condition, Stimulus, and History as factors was applied to food-key response rates. The only significant effect was an elevation of responding during mixed stimulus in the Free S– ses-

Table 1

Pecks per minute on the observing key during Free S–, Free Mixed, and S+ Only sessions in Experiment 1. Means are shown separately for birds that served in previous observing experiments and for birds recruited from an autoshaping experiment.

History	Subject	Free S–	Free Mixed	S+ Only
Observing-trained	2-1	15.10	13.75	12.24
	2-2	8.72	8.53	6.72
	6-1	7.04	5.91	6.47
	6-2	14.86	8.43	9.35
	7-1	28.28	18.53	19.94
	7-2	44.59	38.08	34.91
	1B-1	15.10	13.75	12.24
	Mean	20.58	17.23	16.79
Autoshaping-trained	1B-2	13.40	10.15	10.16
	8-1	11.42	9.16	7.41
	8-2	8.32	8.45	7.46
	9-1	6.59	3.18	2.62
	9-2	12.88	13.78	12.69
	10-1	4.22	1.14	2.90
	10-2	29.26	32.45	26.96
	11-1	16.19	15.39	14.54
	11-2	13.34	14.62	14.10
	Mean	12.86	12.03	10.98

sions. The effect of Condition on food-reinforced responding during the mixed stimulus was highly significant [$F(2, 28) = 11.53$, $p = .0002$]. The Scheffe test for pairwise comparisons produced statistical significance both for the difference between Free S– and S+ Only ($p < .001$) and for the difference between Free S– and Free Mixed sessions ($p < .05$). The difference between Free Mixed and S+ Only sessions was not significant.

DISCUSSION

Free presentations of S– produced higher observing rates as compared to sessions without free stimulus presentations. Free presentations of S– also produced higher rates of observing in comparison with presentations of the Free Mixed stimulus. The effect was significant in pairwise comparisons only when all subjects were considered; when only birds without previous observing histories were considered, statistical significance was not achieved. However the Scheffe test is conservative, and the data obtained from the autoshaped birds are qualitatively similar to the data from the entire group of birds.

Because the Scheffe test is conservative, the failure of the difference between Free Mixed

and S+ Only sessions to achieve significance should not be taken as definitive. It is possible that some set of factors controlled in the Free Mixed condition does tend to raise observing rates. Some of the increase in observing rates caused by S− presentations could be due to such factors. However, the fact that a statistically significant difference occurs between Free S− and Free Mixed sessions indicates that the negative signal value of the S− has an independent effect on rates of observing for S+. The magnitude of the effect was small. However, as the high levels of statistical significance suggest, it was consistent across subjects. The results therefore support the hypothesis that the presentations of S− increase rates of observing.

Rates of food-key responding during the mixed stimulus were significantly higher during sessions in which the Free S− was presented. This increase cannot be attributed to the fact that density of food reinforcement during the mixed stimulus is higher during Free S− than during S+ Only sessions. Food-key rates during the mixed stimulus were also higher in Free S− than in Free Mixed sessions, when the density of food reinforcement in the mixed stimulus was matched to food density during Free S− sessions.

The increased rates of food-reinforced responding during the mixed stimulus is noteworthy in two respects. First, it suggests that the enhancement of observing rates by S− is not related to a concurrent decrease in rates of food-reinforced responding during the mixed stimulus. Rather, these rates increase, and observing rates also increase in spite of potential competition with increased food-key rates. On the other hand, the effect of the S− is not confined to observing rates. The fact that the S− increases all key pecking during the mixed stimulus suggests that it might produce some sort of general response activation.

EXPERIMENT 2: RATES OF RESPONDING FOLLOWING OFFSETS OF NONCONTINGENT STIMULI

When the S− is present in observing procedures, discriminable transitions occur from the zero density of reinforcement marked by S− to the higher density of reinforcement marked by the mixed stimulus. Possibly the

increased rates of observing and food responses that occur during the mixed stimulus are due to these transitions. Specifically, transitions from low to higher densities of reinforcement could elicit key pecking in an effect that resembles local, or transient, contrast (e.g., Boneau & Axelrod, 1962; Nevin & Shettleworth, 1966; Schwartz & Gamzu, 1977). Experiment 2 repeated the manipulations used in Experiment 1 and provided for records to be kept of observing rates immediately following offsets of free stimuli.

METHOD

Subjects and Apparatus

Fourteen subjects from those that served in Experiment 1 served again in Experiment 2. Seven had observing histories and seven autoshaping histories. The apparatus used in Experiment 1 was again used in Experiment 2.

Procedure

As in Experiment 1, three conditions were studied: Free S−, Free Mixed, and S+ Only. Two procedural changes were made in Experiment 2. First, free S− and free mixed stimuli were presented at variable time intervals, as opposed to the fixed time intervals used in previous experiments. Second, the free mixed stimulus was always displayed whenever it was "set up" by the variable-time programmer. That is, the free mixed stimulus could interrupt the display of S+ in Experiment 2, whereas in Experiment 1 the free mixed stimulus was allowed to interrupt only the regular mixed stimulus. The new procedure allowed better control of the percentage of mixed-stimulus time spent in the variable-interval component of the food schedule.

As in Experiment 1, each nine-session test series consisted of three contiguous daily sessions of each condition (S+ Only, Free S−, and Free Mixed). The order of the conditions was determined randomly for each squad of two birds. Data from the first session in each condition were discarded, and data from the two remaining sessions were averaged to yield a single data point.

RESULTS

Table 2 presents mean and individual data from Experiment 2. Observing rates are shown

Table 2

Individual and mean pecks per minute on the observing key from Experiment 2. Rates are shown for the entire mixed-stimulus periods, for 5-s periods immediately following free stimulus offsets, and for portions of mixed stimuli that did not immediately follow free stimulus offsets (control).

Subject	Free S–			Free Mixed			S+ Only
	All Mixed	Post Offset	Control	All Mixed	Post Offset	Control	All Mixed
6-1	5.27	3.22	5.49	4.36	3.92	4.38	5.74
6-2	12.79	12.00	12.86	7.79	6.23	7.91	10.00
7-1	20.50	35.91	18.88	19.00	14.58	19.46	20.34
7-2	38.82	72.08	35.26	32.21	30.54	32.38	31.77
1B-1	12.41	11.13	12.52	11.98	10.16	12.12	9.04
1B-2	14.71	21.43	13.49	11.16	10.15	11.24	12.38
8-1	13.44	21.80	12.67	12.72	22.78	12.01	10.37
8-2	10.86	8.87	11.14	10.44	14.68	10.13	10.32
9-1	2.14	3.28	2.10	6.16	2.30	6.48	2.48
9-2	16.21	22.72	15.63	14.94	15.39	14.90	16.63
10-1	4.44	8.76	3.97	6.12	3.67	6.30	5.90
10-2	35.11	47.64	33.92	30.94	40.50	30.19	27.46
2B-1	23.60	73.39	19.26	16.42	20.39	16.08	22.07
2B-2	10.36	32.46	8.49	11.82	12.46	11.77	10.24
Mean	15.72	26.76	14.69	14.00	14.84	13.95	13.91

for all mixed-stimulus time, for 5-s periods immediately following offsets of free stimuli, and for the remainder of the mixed-stimulus not included in these poststimulus periods. As in Experiment 1, mean observing rates during the mixed stimulus as a whole were higher in Free S– sessions than in Free Mixed or S+ Only sessions. Analysis of variance with Condition and History as factors yielded a significant effect only for Condition [$F(2, 24) = 3.652, p = .041$]. The Scheffe test for post-hoc comparisons yielded no significant effect. However, with the Duncan Multiple Range Test, a less conservative test, both the difference between Free S– and S+ Only and the difference between Free S– and Free Mixed were significant at the .05 level. When responses that occurred during the 5-s periods following stimulus offsets were excluded from the same analysis, the effect of Condition was no longer significant.

As the data in Table 2 suggest, observing rates were higher immediately following offsets of S– than during the remaining mixed-stimulus time in Free S– sessions [$t(13) = 2.74, p < .025$]. For Free Mixed sessions, this difference was not statistically significant. This set of results suggests that increased observing rates found during Free S– sessions were due to locally elevated rates of observing that occurred immediately following offsets of S–.

DISCUSSION

The results of Experiment 2 replicated the enhancement of observing for S+ by presentations of S–. However, separate recording of observing responses that occurred during 5-s periods following offsets of free stimuli showed that the effect occurred mostly, if not entirely, during such periods.

The post-S– responding found in Experiment 2 is probably related to an effect obtained in studies of behavioral contrast. In the standard, free-operant procedure used to study behavioral contrast, the density of reinforcement in one component of a multiple schedule is reduced and the effect on the rate of responding in the second, unchanged component is studied. When responding in the unchanged component increases, positive behavioral contrast is said to occur. Analysis of the temporal patterning of the increased responding in the unchanged component has shown that especially high rates of responding occur immediately after the transition from the low- to the high-density component. These increases have been called "transient" (e.g., Mackintosh, 1974) and "local" contrast (e.g., Schwartz & Gamzu, 1977).

The presence of the S– in observing procedures provides a signal for transitions from low to higher density reinforcement. It seems
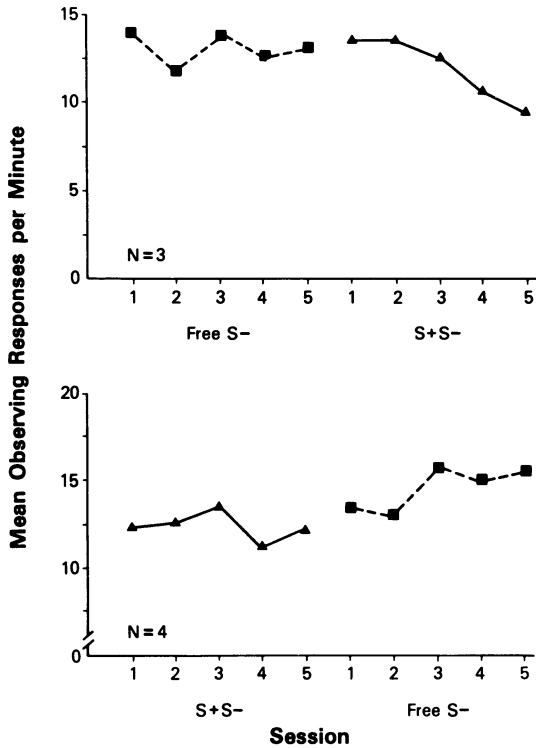
Fig. 1. Mean pecks per minute on the observing key during sessions in which S− was contingent upon observing responses (S+S−, triangles) versus not contingent upon observing responses (Free S−, squares). Means are shown separately for the two orders of treatment.

appropriate, therefore, to attribute the effect of S− on observing responses to local contrast.

EXPERIMENT 3: RATES OF OBSERVING WITH A CONTINGENT VERSUS A NONCONTINGENT S−

In an experiment with rhesus monkeys that has been described as "the only truly provocative support of the notion that bad news is reinforcing" (Fantino, 1977, p. 322), Lieberman (1972) found a decrease in observing when the S− was eliminated from an observing procedure. Similar results have been obtained using pigeons (Mueller & Dinsmoor, 1984). However, when the response-contingent S− is eliminated from an observing procedure, both the *presentations* of the S− and the *contingency* between observing and the S− are eliminated. The major purpose of Experiments 1 and 2 in the present series was to disentangle these two aspects of the manipu-

lation. The results showed that presentations of a noncontingent S− can raise rates of observing, probably by a process related to local contrast.

In Experiment 3 the complementary manipulation was made: The presence of the S− was held constant, but in some sessions the S− was contingent on observing responses and in other sessions noncontingent S− presentations were made. This variant of Lieberman's procedure represents a fairer test of the ability of the S− to reinforce observing, because only the contingency between observing and S− is varied. The results should be free of irrelevant changes in observing rates produced by the presence or absence of the S−.

METHOD

Subjects and Apparatus

Seven of the subjects from Experiments 1 and 2 that had histories of autoshaping were used. The apparatus was the same as that used in Experiments 1 and 2.

Procedure

Two treatment conditions were studied. In *Free S−* sessions, as in previous experiments, observing responses produced only S+, and presentations of S− were independent of responding. In *S+S−* sessions, both S+ and S− were produced by observing responses. During Free S− sessions, the procedure used in Experiment 2 was used again. During S+S− sessions, a response was required to produce S−, as it was to produce S+.

The squads of two subjects were randomly assigned to one of two possible treatment sequences. Five sessions of the first condition were conducted, followed by five sessions of the second condition. Data from the last two sessions of each five-session block were averaged to yield a single score for statistical analysis. One 10-session series was conducted as a training series. Test data were collected from the second 10-session series.

RESULTS

Figure 1 shows separately for each test session and for the birds in each treatment sequence the mean rate of observing during the mixed stimulus; data for individual birds are

Table 3

Individual subjects' data from Experiment 3 (means are shown in Figure 1). Data are pecks per minute on the observing key during sessions in which S— was contingent upon observing responses (S+S—) versus not contingent upon observing responses (Free S—).

Subject	Condition	Session				
		1	2	3	4	5
8-1	Free S—	3.20	5.81	6.04	6.57	5.49
	S+S—	3.93	3.24	2.56	2.80	3.12
8-2	Free S—	6.20	3.15	5.75	7.11	6.48
	S+S—	8.58	8.21	7.60	6.61	7.18
11-1	Free S—	33.18	26.94	29.89	24.17	27.72
	S+S—	28.22	29.35	27.68	22.75	18.28
9-1	S+S—	2.93	2.44	1.47	1.77	2.95
	Free S—	3.35	3.07	8.72	7.72	5.31
9-2	S+S—	18.42	16.07	17.96	11.95	15.47
	Free S—	16.03	16.04	19.37	18.26	20.25
10-1	S+S—	5.45	7.45	8.19	5.98	4.21
	Free S—	4.98	3.87	5.50	5.01	8.38
10-2	S+S—	22.15	24.12	25.93	24.46	26.35
	Free S—	29.37	29.08	29.33	28.86	28.06

shown in Table 3. Observing rates during Free S— sessions increased to levels higher than during S+S— sessions. As planned, a *t* test for correlated scores was conducted on data collected during the last two sessions of each five-session treatment block. The difference between the two conditions was significant [$t(6) = 4.23$, $p = .006$].

To ensure that the results were not due to greater frequency of presentation of S— in the Free S— condition, the proportion of session time occupied by S— displays was calculated. The mean proportion for all Free S— sessions was .14 and for all S+S— sessions was .13. Mean proportions were also calculated for the last two sessions in each condition, the sessions used for statistical analysis. The mean proportions during those sessions were also .14 for Free S— and .13 for S+S— sessions.

DISCUSSION

As predicted by theories of observing that characterize the S— as punishing, observing rates were lower when S— was contingent upon observing than when S— was presented independently. Theories, such as the information theory of observing, that imply that the S— is reinforcing, would of course predict that higher rates of observing would be maintained by the contingent S—. The result indicates that decreases obtained by eliminating

the S— from observing procedures are due not to the failure of observing responses to produce S—, but to the elimination of the presence of S— from the procedure.

GENERAL DISCUSSION

The principal evidence supporting the information theory of observing has been provided by experiments in which a response-dependent S— has been eliminated from an observing procedure and rates of observing have declined. The present series of experiments has demonstrated (1) that presentations of S— are sufficient to raise observing rates, whether or not the S— is produced by the observing responses; (2) that the S— raises rates by a local-contrast-like effect, in which bursts of responses occur following offsets of S—; and (3) if only the contingency between S— and observing is eliminated, with the presence of S— held constant, higher rates of observing occur. Thus, the results obtained by Lieberman (1972) and by Mueller and Dinsmoor (1984) were probably due to the elimination of the presence of S—, as opposed to the elimination of the contingency between observing and S—.

Factors other than the one isolated in the present series of experiments could cause presentations of the S— to increase observing

rates. For example, if the duration of the discriminative stimuli is long, relative to the duration of the schedule components, offset of S— can serve as a signal for a change of schedule component. In such cases, offsets of S— should produce larger numbers of responses than were obtained in the present experiments. The procedure used by Lieberman with rhesus monkeys differed in many ways from the procedure we have used. Nevertheless, the central point remains: Elimination of the S— from an experimental procedure is not an adequate test of its ability to reinforce observing responses. The presence of the S— must be kept constant while the contingency between responses and stimuli is manipulated.

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